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## THE ENCYCLOPÆDIA BRITANNICA.

*The Encyclopaedia Britannica*, vols. xxviii. and xxix. Being the Fourth and Fifth of the New Volumes. Ele-Gla. Pp. xix + 742. Gla-Jut. Pp. xx + 763. (London: A. and C. Black, and the *Times*, 1902.)

THE prefatory essay to vol. xxviii. is by Sir Leslie Stephen upon the subject of "The Growth of Toleration." It is pointed out that one dominant factor in the development which has taken place has been the growth of the natural sciences; and reference is made to the influence exerted by scientific investigation upon traditional beliefs and dogmas. Mr. Benjamin Kidd contributes to vol. xxix. a prefatory essay on "The Application of the Doctrine of Evolution to Sociological Theory and Problems."

There are many scientific articles in the two volumes, several being of great importance. Among the articles to which attention must be directed are the following:—Vol. xxviii.: Electricity and electricity supply, by Prof. J. A. Fleming, Mr. W. C. D. Whetham, Prof. J. J. Thomson, Dr. L. Duncan and Mr. E. Garcke; electrochemistry, Mr. W. G. McMillan; electromagnets, Prof. J. A. Fleming; embryology, Mr. Adam Sedgwick and Dr. A. E. Driesch; energetics, Dr. J. Larmor; engines, Prof. J. A. Ewing; England and Wales (geography), Dr. H. R. Mill; Entomostraca, Rev. T. R. R. Stebbing; evolution, Dr. Chalmers Mitchell; fisheries, Mr. W. Garstang; forests and forestry, Prof. W. Schlich and Mr. G. Pinchot (United States); Fourier's series, Dr. E. W. Hobson; analytic functions, Mr. H. F. Baker; functions of real variables, Prof. A. E. H. Love; fungi, Prof. Marshall Ward; fusion, Prof. H. L. Callendar; gas and gas lighting, Prof. V. B. Lewes; gaseous fuel, Prof. G. Lunge; artificial gems, Sir William Crookes; geography, Dr. H. R. Mill; geology, Sir Archibald Geikie; geometrical continuity, Rev. Charles Taylor; line geometry, Mr. J. H. Grace, and non-Euclidean geometry, the Hon. A. A. W. Russell. Vol. xxix.: Theory of groups, Prof. W. Burnside; gunnery, and gyroscope, Prof. A. G. Greenhill; gymnosperms, Mr. A. C. Seward; halos, the late Prof. P. G. Tait; Helmholtz, Prof. J. G. McKendrick; hemichorda, and hydrozoa, Dr. G. H. Fowler; heredity, and hybridism, Dr. P. Chalmers Mitchell; Huxley, Sir W. T. Thiselton-Dyer; hygiene, Colonel J. Lane Notter; ichthyology, Dr. A. Günther; insects, Dr. D. Sharp; iron and steel, Prof. H. M. Howe; irrigation, Sir Colin Campbell Scott-Moncrieff.

It is impossible to describe the whole of these articles in a notice of limited length, but from this group of scientific contributions to the "Encyclopædia" we select a few for brief notice.

So large a part, nearly one-sixth, of vol. xxviii. is devoted to electrical subjects that we cannot, with the space at our disposal, do much more than enumerate the branches treated. Under the heading "Electricity," Prof. Fleming writes on electric conduction, current and units; Prof. J. J. Thomson on discharge through gases and electric waves; and Mr. Whetham on electrolytic conduction. These articles cover the greater part of electrical theory; the practical applications are dealt with in separate contributions. Mr. Whetham's discussion of electrolytic conduction gives a full and favourable account of the dissociation theory; the student has therefore an opportunity, from this article and from that by Prof. Armstrong on "Chemistry," of considering both sides of the question. The electrochemist is indeed particularly well catered for in the new volumes, since, in addition to the articles already mentioned, Mr. McMillan contributes two articles to the present volume on "Electrochemistry" and "Electrometallurgy." These deal with the industrial applications, the first with refining of metals, electrotyping and plating, and alkali and chlorate manufacture; and the second with furnace processes, such as the production of aluminium and calcium carbide. A contribution on "Electromagnet," written by Prof. Fleming, discusses magnetic flux, permeability and hysteresis. A long article on "Electricity Supply" deals with the principle of lighting by arc and incandescent lamps, with electric traction, and with the commercial aspects of the industrial development of electricity. The treatment of electric traction is hardly adequate if this is all that is to be given in the "Encyclopædia"; for one thing, the article is entirely without illustration, a great disadvantage to the general reader. It is also to be noticed that there is a certain amount of repetition which might have been avoided; thus, the theory of the arc is discussed at some length by both Prof. Fleming and Prof. J. J. Thomson.

"Energetics" is a name commonly associated with a philosophy which proposes to abolish Newton's laws of motion and to deduce all the equations of dynamics from the single equation of energy. Dr. Larmor's article deals with a much more useful field of study, including Carnot's principle, the general thermodynamical equations, free and available energy, and Gibbs's important work on the equilibrium of chemical systems. It forms a excellent introduction to the study of thermochemistry.

Pure mathematics is well represented in the present volumes. In an article on the "Error Law," Mr. Edgworth gives an account of the various proofs of the common law of error and of Prof. Weldon's experimental verification, corrections for cases in which the number of elements is finite, normal and abnormal correlation, and applications to various problems in statistics. In the account of Fourier's series, Dr. Hobson divides the historical development of the theory of the representation of functions by trigonometric series into three periods, the first period opening with the work of D'Alembert, Bernouilli and others in connection with vibrations of strings, the second with Fourier's memoir of 1807 on the "Theory of Heat," and the modern period being inaugurated by Riemann's memoir of 1867. The article on "Analytic Functions" contains a good general account of Weierstrass's methods; that on "Functions of Real Variables" deals largely with the *continuum* of real numbers, the domain of a variable, the doctrine of continuity, and the questions of differentiability and integrability of functions. Under "Line Geometry," we have a discussion of the properties of linear and non-linear complexes, congruences and ruled surfaces. In the article on "Non-Euclidean Geometry," Mr. Russell traces the genesis of this important branch of pure

mathematics out of the attempts of mathematicians to improve the theory of parallels. A historical account is given of the development of the new geometry by Gauss, Lobatchewsky, Bolyai, Riemann and Beltrami. Considerable attention is given to the three prevailing misconceptions which have retarded the development of the subject, namely, the introduction of a fourth dimension in connection with the notion of curvature of space, the projective definitions of distance and angle, and the necessity for introducing rigid bodies in geometry.

The writer of the article on evolution has had a difficult task, with which, on the whole, he has grappled successfully. We miss, however, any clear presentment of the crucial point on which the controversies that at present divide evolutionists indisputably turn—viz. that of the transmission or otherwise of modifications due to individual plasticity. It seems inadequate to say, without explanation, that "the weakness of the neo-Lamarckian view lies in its interpretation of heredity," when, as a matter of fact, the whole neo-Lamarckian fabric must fall unless the reality of such transmission can be established. The summaries given of several modern developments of evolutionary theory are scarcely full enough to be of much value to the specialist, while the unskilled but intelligent reader in search of information, whose requirements should always be kept in view in a work like the present, will, we fear, find their language often too technical to give him what he wants. The writer tells us that

"multiradial apocentricities lie at the root of many of the phenomena that have been grouped under the designation of *Convergence*."

We should say rather that the first phrase merely repeats the idea of the second in a more cumbrous form. Moreover, we doubt whether anyone not an expert would grasp the meaning of either expression, or that of "homogeneous homoplasies," without illustration. The account given of the recent departure in biometrics is good so far as it goes, and the position of its exponents is not unfairly stated; justice, however, is hardly done to the fact that the quantitative stage is inevitable in any inquiry the material of which admits of measurement. Workers in this department are fully alive to the danger pointed out by Dr. Mitchell, and analysis of composite characters is making progress under the stimulus supplied by the rediscovery of Mendel.

The article dealing with forests and forestry is in two parts, the general part by Dr. Schlich, C.I.E., F.R.S., and that referring to the United States of America by Mr. Gifford Pinchot, Forester of the U.S. Department of Agriculture.

Dr. Schlich first deals with the general distribution of forests throughout the world, and this might with advantage be more detailed. His account of the utility of forests based on their indirect and direct advantages is admirable, the former being chiefly the prevention of the denudation of hill-sides and of the consequent flooding of low-land and the silting-up of river-beds. The direct utility of forests increases steadily with the population of civilised countries, and it is a remarkable proof of the effects of economic progress that whereas in 1880 Germany produced as much timber as she required, in 1899 she imported 4,600,000 tons, valued at 14,000,000*l.* and this in spite of the increasing yield-capacity of her State forests. The latter comprise about one-third of her forest area, but as continental communal forests are chiefly managed by the State, it is a pity that they are not separated from private forests in the table of areas, for continental private forests are frequently no better managed than our own. Eighty-seven per cent. of the timber we import yearly, worth about 22,000,000*l.*, is coniferous, and it is chiefly on Canada, with 1,250,000 square miles of forests, that the world will have to depend for the future. Curiously, the table showing movements of timber within the British Empire entirely omits Canada.

Dr. Schlich appeals to the landowners of Britain to afforest 3,000,000 of our 24,000,000 acres of lands either waste or used for light hill grazing, and for more attention to forestry by our colonies, most of which are no better than Canada in this respect. He gives an interesting account of forest management in India, the managed State forests of which, comprising, in 1900, 95,000 square miles, 10 per cent. of the area of British India, yielded (1890–95) an average net revenue, which is steadily increasing, of 73,70,000 rupees. Progress in forestry is also being made in South Africa and Ceylon.

Mr. Pinchot gives a good summary and a map of the distribution of forests in the United States, the chief causes of destruction of which are over-lumbering and fires. He gives a map of the present State reserved forests, which, although amounting in area to 72,500 square miles, look inconspicuous on the huge territory of 3,500,000 square miles. He has also drawn up a useful history of the State protection of forests, which was greatly assisted by the large reservations carried out by President Cleveland and the forest law passed in 1897, the general purport of which he explains and praises.

Forest education has progressed in America, forestry being taught at several universities and other institutions. Mr. Pinchot states, however, that European forestry is not yet applicable to America, but that the production of a net revenue and the perpetuation of the forest are the chief objects of the private forest owner, who is the principal timber producer in the States. There is an account given of the lumber trade, and the ominous note occurs that numbers of the eastern white pine lumber- and mill- men have removed to the southern States and Pacific Coast, driven away by the exhaustion of their supplies. From Dr. Schlich we learn that already the United States imports from Canada nearly as much timber as it exports.

The article "Geology" is written happily by the same authority, Sir Archibald Geikie, who contributed the elaborate essay in vol. x. of the ninth edition. He divides his subject as before into sections, and reviews in the same lucid manner the general progress made during the interval. In its cosmical aspects, the record is not, however, one wholly of progress, as Croll's astronomical theory is no longer considered to afford a solution of the problem of the Ice age. Many have dealt with the question of the earth's age, notably Sir A. Geikie, and we cannot wonder that he repeats his protest against the time-restrictions of physicists and mathematicians. No evidence of progressive diminution of activity, whether of

the sea or of volcanoes, is preserved among the rocks; their record, indeed, is one of singular uniformity, despite the catastrophes of Krakatoa in Sunda Strait and of Bandai-san in Japan, to which attention is directed. Much has also been learnt about fissure-eruptions. Here we are in touch with the author's special subject, and he devotes a considerable space to the volcanic history of the British Isles. To petrography, which no doubt is dealt with in a special article, but brief reference is made.

A glance at the article on geography shows how intimately it has become linked with geology during the past quarter of a century, thanks to the labours of Suess, Penck, Lapworth and W. M. Davis. The fact that the surface of the sea preserves no uniformity, and that it may locally rise and fall to a considerable extent without change in the lithosphere, would seem to revolutionise our ideas about raised beaches and submerged forests; but the author points to certain regions where there is definite evidence of slow upheaval or depression of land. The indications of changes of level derived from a study of coral-reefs are also discussed.

Structural geology naturally occupies some space, and special reference is made to the great flexures and overthrusts that have been determined in many regions. Palæontological zones receive attention, for on this subject great progress has been made, and although we miss reference to the brilliant researches of Dr. A. W. Rowe, the importance of the subject is fully admitted. We agree with the author that there is much yet to be solved in the problem of life-zones. Special mention might have been made of observations on radiolarian chert, but in so complex and many-sided a subject as geology we feel that the author has done all that could well be done to illustrate its progress in a limited space.

Prof. Greenhill's two contributions on ballistics and the gyroscope and gyrostat are full of material of interest to students of dynamics. In a short essay Sir W. T. Thiselton-Dyer summarises the chief points of Huxley's life and work, and contrives to express the essential characters of each in a few pages. Dr. Günther has brought the article on fishes up to date. In 1870 the number of known species of living fishes was stated as 8525, but since then it has been nearly doubled. Knowledge of the distribution, organisation and development of fishes has also made substantial progress, and Dr. Günther gives a survey of the most important advances.

The article on insects is by Dr. David Sharp, whose general knowledge of the subject is probably more extensive than that of any other living entomologist. Nevertheless, it is obvious that the space at his disposal was utterly inadequate to permit of his attempting more than a mere glance at a few of the more interesting matters connected with entomology that have been discussed in recent years. Among these are the number of species of insects; antiquity; duration of life (inadequately discussed; but the fact of a water-beetle living five and a half years in captivity was new to us, though some of Lord Avebury's Queen ants have attained a much greater age); economic entomology (with special reference to Coccidæ, and to insects and malaria); luminosity (concerning which Dr. Sharp remarks, "The light given by insects has been shown to be highly economical, and if a similar illuminating agent can be produced artificially it will be a reat boon.' Granted; but then there is the immense initial difficulty of producing or imitating organic chemical substances artificially); galls; anatomy and morphology (with special reference to the structure of the segments of the head); metamorphosis; classification (twenty-two orders are now recognised, the sequence of which differs considerably from that followed in the author's "Cambridge Natural History," published in 1899) and ethology (referring to intelligence and to social insects). The article concludes with a paragraph of "authorities," including references to a few recently published books and papers on insects; but the list is necessarily so short and incomplete that we think it might almost as well have been omitted altogether.

Though limitations of space have prevented some of the writers from doing full justice to their subjects, the volumes are rich in matter of interest to the student of science, and furnish substantial evidence of progress in many branches of natural knowledge.

## THE STUDY OF THE PROTISTA.

*Archiv für Protistenkunde.* Herausgegeben von Dr. Fritz Schaudinn. Band i. Heft 1. Pp. 192; 5 plates. (Jena: Gustav Fischer, 1902.) Price Mk. 24.

OF late years very rapid progress has been made in our knowledge of that vast assemblage of organisms for which Haeckel set up a special "kingdom" or *Reich* with the name Protista, comprising the simplest living creatures amongst which the distinction of plant and animal is of quite secondary importance. In no branch of biology do works become so quickly out of date as in that which deals with the lowest forms of life. The attention which the Protista have received has been stimulated from two sources. From a purely scientific and theoretical point of view, it is evident that many elementary problems, or fundamental phenomena, of life can be studied in their simplest form, divested of unessential complications, in these lowly organisms. This is especially true of the facts of cytology relating to the structure and activities of cells. The discoveries of the last decade of the nineteenth century have revealed a remarkable uniformity, underlying the greatest variety in form and detail, in the cell-processes of the higher animals and plants, which cannot be considered as satisfactorily understood until the steps are made clear by which they have been evolved from the usually simpler, but in any case far more diversified, types of structure or development which are found to occur in unicellular organisms. It is only necessary to refer to the problems of cell-division and fertilisation in support of this proposition. Quite apart, however, from their claims on the attention of scientific biologists, the Protista are becoming continually more important as objects of study from the practical point of view. Some, as, for instance, the organisms of fermentation, are indispensable for human arts and manufactures; others have a claim to consideration which, if more melancholy, is not less great, on account of the injuries or disease which they inflict as parasites or pathogenic agents upon man, beast, or plant. The importance of the lower organisms from the practical standpoint has already been the cause of specialisation in their study. An instance of this is seen in the rise